

DESIGN AND DEVELOPMENT OF PNEUMATIC STEERING ASSEMBLY FOR AUTOMOTIVE VEHICLES

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering degree in Mechanical Engineering

By

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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with grade “A” by NAAC

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APRIL 2023



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of NEREDUMULLI DINESH (Reg. No. 39150092), MADDI ANAND REDDY (Reg. No. 39150075), who have done the Project entitled **“DESIGN AND DEVELOPMENT OF PNEUMATIC STEERING ASSEMBLY FOR AUTOMOTIVE VEHICLES”**

Under our supervision from December 2022 to April 2023.

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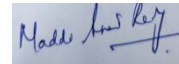
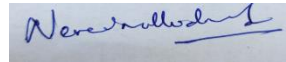
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DECLARATION

We NEREDUMULLIDINESH (Reg. No. 39150092) and MADDI ANAND REDDY (Reg. No. 39150075) hereby declare that the Project Report entitled “**DESIGN AND DEVELOPMENT OF PNEUMATIC STEERING SYSTEM FOR AUTOMOTIVE VEHICLES**” done by me under the guidance of **Dr. G. ARUNKUMAR, ME., PhD.**, is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering in Mechanical Engineering.



DATE:26/04/2023

SIGNATURE OF THE CANDIDATES

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ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my sincere thanks to **Dr. S. Prakash, M.E., Ph.D.**, Dean, School of Mechanical Engineering and **Dr. G. Arun Kumar M.E., Ph.D.**, Head of the Department, Department of Mechanical Engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my guide Dr. **G. Arun Kumar M.E., Ph.D.**, for their valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I also express my thanks to all Teaching and Non-teaching staff members of the Department of Mechanical Engineering who were helpful in many ways for the completion of the project work.

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LIST OF SYMBOLS AND ABBEREVIATIONS

Q _r	Consumption rate of pneumatic system(SCFM,m ³ /min)
Q _c	Output flow-rate of compressor (SCFM, m ³ /min)
P max	maximum pressure level in reservoir (psi, kPa)
P min	minimum pressure level in reservoir (psi, kPa)
V _r	Reservoir size (ft ³ , m ³) Air capacity rating of compressors Air compressors are generally rated in terms of SCFM of free defined as air at actual atmospheric conditions.
P _{in}	Inlet atmospheric pressure (psia, kPa abs)
P _{out}	Outlet atmospheric pressure (psia, kPa abs)
Q	flow-rate (standard m ³ /min)

CHAPTER 1

ABSTRACT

The emergence of technologies such as power steering has helped make driving less burdensome on drivers and increased the pleasure of driving. Power steering systems practically always make use of fluid pressure as a means of assisting the driver in turning the front wheels of the vehicle. The application of air pressure is the driving force behind the operation of pneumatic devices and equipment. Pneumatic systems are any tools or gadgets that make use of air in their operation. This type of apparatus runs at a high pressure. Compressed air is used to power an air-operated actuator, which is used to circulate the machine. The control has an instantaneous impact on the air. It was dispersed throughout the system via the tubes and valves. Two wheels, a pneumatic actuator, and a connection for power steering have all been part of this system, which is mounted on a frame. Every single wheel is attached to the shaft of the pneumatic actuator that controls them. The second wheel is connected to the first. Mounting the pneumatic cylinder stroke, which causes steering, is controlled by the direction control lever. The Pneumatic Power Steering System of the car makes driving it very simple, which are already fluid-powered and low-maintenance.

CHAPTER 2

INTRODUCTION

CHAPTER-2

INTRODUCTION

Many tools and pieces of equipment, including automobiles, have pneumatic steering. Heavy machinery is frequently used as an illustration. Under direct or automatic control from control valves, high-pressure compressed air is supplied throughout the steering system to various pneumatic actuators and cylinders with the aid of hoses and tubes. Pneumatic drives are also simple and affordable. The cylinders, compressors, and pumps are the main parts of this steering system . Due to the pneumatic control system's reliance on compressed air, it must be made accessible in an amount and at a pressure appropriate to the system's capabilities . An effective and secure way to automate a production line is to make pneumatically powered components. The project's scope included the creation and construction of a compressed air test platform that could duplicate a number of operations .

The airflow through the pipe in pneumatic systems is simulated using a linear differential equation based on Newton's second law, accounting for the inertial effects of the air, friction, and local pressure variations [4]. The dynamical link between the actuating forces and a PLSA's two main degrees of freedom, bending and steering, is directly determined using the general PLSAs [5]. The dynamical link between the actuating pressures and the two fundamental degrees of freedom of a PLSA, bending and steering, is derived using the General PLSAs in a parameter-independent manner. The cyclical storage of exhaust air from a few outlets of an industrial-scale arbitrary

pneumatic machine output is being expanded in order to improve the energy efficiency of pneumatic machines. To automate the regulation of the proportionate supply of natural gas. The combination of compressed gas energy storage and a nonlinear cam transformation mechanism results in the proposal of a novel isobaric compressed air storage system. Results indicate that this novel isobaric compressed air storage device performs well in terms of energy use and has favourable constant-pressure properties.

Multiple-joint, multi-DOF forceps manipulators have been developed by businesses and researchers to make doctors less employable. The design and approval of a pneumatic push-pull actuator for vibration isolation, as well as the development of a unique control law for an autonomous vehicle . An investigation of the dynamic features of systems using both experimentation and analysis. TY he development of equations to describe the steering wheel's and the front wheels' two-degrees-of-freedom rotations around the kingpin. This study suggests a H/ extension controller based on an active front steering system by combining the extension control into the H mixed sensitivity control regarding sensitivity f . The control's objective is to keep lanes open while adhering to a number of constraints, including actuator saturation of the steering system, an unidentified road's curvature, and an undetermined lateral wind force . The force-balance idea and its The use of pneumatic controls, the roles of temperature and pressure in these systems, and the usage of spring ranges to sequence valves and dampers are all covered. According to the force-balance principle, the enclosure or chamber contains three apertures or ports: one for the supply air intake, one for the output of the control signal, and one for the exhaust .

Pneumatic control valve friction issues were somewhat frequent. The basic pneumatic control valve components, such as the valve positioner, valve actuator, and valve body, serve as the foundation for the new semi-physical model for sticky pneumatic control valves proposed in this study. In terms of space efficiency, engine economy, and environmental friendliness, electric power steering (EPS) systems offer a number of advantages over conventional hydraulic power steering. To generate various steering sensations, lessen driver-exercised steering torque, and enhance

return-to-center performance, an EPS control algorithm was developed. All of the auxiliary systems typically seen in heavy-duty vehicles (such the power steering pump and air conditioning compressor) are engine-driven, which significantly restricts their performance. Engine speed influences energy consumption as well as outputs (such speed and temperature), even though most auxiliary requirements are unrelated to engine speed. When used, electromagnetic solenoid valves' (SVs) fundamental properties—such as reliability, effectiveness, and remaining useful life (RUL)—regulate their operation in a safe and effective manner. The design and mechatronic requirements for an electrical power steering simulator. In addition to being portable and modular, the simulator's architecture is as identical as it is possible to be, and its steering mechanism is comparable to that of a genuine car. Using a linear quadratic Gaussian, the best control strategy for the tractor's semi-active suspension is created. The simulation makes use of a detailed automotive model as well as a hydro-pneumatic suspension system model created with Simulation X and MATLAB/Simulink. The power-assisted steering system is an improvement in automotive dynamics that increases driver comfort by lowering steering effort and responding more swiftly than a traditional manual steering system.

CHAPTER-3

LITERATURE SURVEY-3

CHAPTER-3

LITERATURE SURVEY

S.NO.	YEAR	AUTHOR	INFERENCE
1.	2019	(J.S.Leszczynski,D.Grybos.,2019)	Cyclic storage of exhaust air from selected outlets of an industrial scale arbitrary pneumatic machine.
2.	2020	M.Damir, M.AbouAli,A.damir.,2020	The proposed novel isobaric compressed air storage device provides a new way to reduce pressure and energy consumptions of pneumatic system

3.	2019	(Sebastian Brol [*] , Rafał Czok, Piotr Mroz.,2019)	In pneumatic energy container used to feed the pneumatic engine. The accumulator usually contains containers with bladder filled with compressed gas.
4.	2011	Andrew PARR MSc, CEng, MIEE, MInstMC	Most control valves, however, are only used to allow or block the flow of fluid. Such valves are called finite position valves. An analogy between the two types of the valve is the comparison between an electric light dimmer and a simple on/ off switch. Connections to a valve are termed 'ports'
5.	2021	Hu Wang, Zhengren Tong, XinDong, Wei Xiong, David S, Rupp Carriveau.,2021)	The proposed novel isobaric compressed air storage device provides a new way to reduce pressure and energy consumptions of pneumatic system.

6.	2020	(Fei-xiang, Chen Zhou , Xin-hui Liu.,2020)	The hierarchical control strategies of the multi-mode steering system consist of the upper controller and the lower controller. The upper controller is responsible for assigning then Steering angles of four wheels of the ERVs based on the Ackerman principle. The lower controller is used to control the ERVs to turn four wheels independently
7.	2015	(W.Manning.,2015)	If the wheel has side slip, as a force that is perpendicular to its rotation plane is generated. This force could be regarded as a reaction force that prevents side slip when the wheel produces a side-slip angle. This is an important force that the vehicle depends on for its independent motion. The side-slip angle is small, these two are treated as the same. This force corresponds to the lift force, explained in fluid dynamics, which acts on a body that travels in a fluid at an attack angle.

8.	2017	Masato abe,2017	The torque, T_h, provided by the human driver at the steering wheel can be seen as an external moment. On the other hand, when the vehicle is moving with a certain steering wheel angle, there is a torque acting to bring the steering wheel back to its original position. This is due to the moment around the kingpin produced by the lateral force that acts at the front wheels. This must also be taken into account as an external moment to the steering system.
9.	2018	McRuer DT.,2018	The driver inside the vehicle is assumed to look forward to $L(m)$ ahead of the vehicle and estimate the deviation of the vehicle's lateral displacement relative to the target course. The estimated lateral displacement is a lateral component of the vehicle traveling distance in a time of L/V at the current attitude .

10.	2018	James Balkwill	The vehicle has some modest forwards speed, there must be a lateral force being developed at both the front and the rear tyre. This in turn requires that the rear tyre has a slip angle. This is α_R. With this in place, we can again draw a line perpendicular to the direction of travel, and where it meets a similarly constructed line from the front tyre, we find the centre about which the vehicle is cornering to be at D. This centre has moved forwards and is well ahead of the rear tyre centre line, though not as far as being level with the centre of gravity.
11.	2013	(XIAOCHEN WANG*, TAO GENG, YAHYAELSAYED, CHAKRAVARTHINISA AJ, CONSTANTINA LEKAKOU.,2013)	Pneumatically-driven Low-pressure Soft Actuators (PLSA). They are compactly designed in small sizes and safely operated at low pressures. An immediately foreseeable application is endoscopes. The latter commonly have much larger sizes and higher operation pressures. But both the PLSAs and the PMAs are in the class of the pneumatically-driven soft continuum robots, and they share many similar properties.
12	2017	(LIANG DANG, HUAIGUANG YANG, HAIBOGAO NAN KI.,2017)	wheel steers in-situ, the sinkage will increase with an increase in the steering angle. The steering process is a dynamic interaction between the wheel and the soil

			that causes the soil to produce a lateral flow and longitudinal compaction. The soil flow makes the wheel's sinkage increase. As a wheel-soil interaction parameter, the sinkage exponent can characterize the degree to which the wheel can sink, and illustrate the comprehensive effect of the soil flow and compaction. Therefore, the variable sinkage exponent model can improve the accuracy of the steering model.
13	2019	HansJoachimFo rster, Gaus	Equipment that permits different speeds at input and output without altering the transmitted torque equipment that permits one to vary the power factors torque and angular velocity between in- put and output without altering the transmitted power. Synonyms include transmission, gearbox, and continuously variable ratio transmission (CVT).
14	2015	(Eiichi ono, Kaoru Takanami.,2015)	In the vehicle control system, it is necessary to consider the change in parameters of the vehicle model with the vehicle driving enviornments and the driving velocity.

15	2009	M.H. Aghkhani*, M.H. Abbaspour-Fard	The steering inaccuracy of this system was 4% and 9.6% more than the maximum allowable inaccuracy (based on design specifications) and asphalt surfaces, respectively. Based on these results and the preliminary assessment of the system, it can be concluded that, this simple and relatively inexpensive automated steering in motor was selected based on the required moment to rotate the Massey–Ferguson MF285 steering wheel rod. method is likely to be accurate enough
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16	2018	S. Nithyananth, A. Jagatheesh, K. Madan, B. Nirmalkumar	A derivation based on the derivative approach is provided, showing the conditions that must be satisfied for a vehicle to have both a neutral understeering gradient and a critically damped steering response.
17	2012	G. Samavedam J. Gomes D. Wormley	When the car was pulled the instrumented wheelset was trailing and conversely when the test car was pushed the instrumented wheelset was leading
18	2019	Guangyang, surenchen, Feng chen	Time-dependent simulation results of stochastic traffic flow, including instantaneous speeds and positions of each vehicle as a part of simulated traffic flow. Simultaneously, complex geometric and other environmental conditions of the highway system

			are also considered realistically, not only during the safety assessment process, but also in quantifying the wind loads applied on the vehicles.
19	2016	Anh-Tu Nguyen, Chouki Sentouh, Jean-Christophe Popieul(2016).Takagi-Sugeno	Autonomus vehicle.the control goal is to perform lane keeping under multiple constraints, namely actuator saturation of the steering system roads with unknown and with uncertain force
20	2019	Osinskiy Yuriy, Danilov Vadim	These circular oscillations of the driving element are caused by the forces perpendicular to the axis of rotation of the driven element. These forces are created by pneumatic elements of a certain type, hereafter referred to as pneumatic drives (PD)
21	2020	Hangyu Lu, GaborStepan,Denes Takacs	In the dynamics of vehicle handling, time delays are mainly caused by the reaction delay of the human driver, the time lag in the steering assembly, and the propagation of the transient deformation appearing in the elastic tyre–road contact.
22		Godage,D.Branson,E.Guglielmino,D.Caldwell	Characterization of the effect of various applied loads and actuationprinciplesnecessitates he development of an accurate dynamic model Unlike traditional robots, the dynamic modeling of a continuum manipulator is not straightforward due to under-actuation.

COMPONENTS OF PNEUMATIC STEERING SYSTEM

CHAPTER-4

COMPONENTS OF PNEUMATIC STEERING SYSTEM

The major components involved in the design and the fabrication of the Pneumatic power steering system are as follows.

- Pneumatic cylinder/actuator
- 5/2 Double acting solenoid valve
- Connectors
- Hoses
- MS circular discs
- Air compressor

Pneumatic actuator

Devices known as pneumatic cylinders are able to transform the potential energy of compressed air or gas into a mechanical motion that may then be used to drive one or more final control elements. As shown in Fig.4.1



Fig.4.1 Pneumatic actuator

5/2 Double acting solenoid valve

The double-acting pneumatic actuators typically use the 5/2 and 5/3 solenoid valves for directional control. Single-coil 5/2 valves often use a return spring or pilot air when the power is cut. Double acting solenoid valves can be made from a variety of materials including nylon, PVC, nickel-plated brass, and stainless steel . As shown in Fig.4.2



Fig.4.2 5/2 Double acting solenoid valve

Connectors

In order to attach compressed air tools to a compressed air line, pneumatic connectors are employed. Pneumatic couplers make it easy to connect and disconnect tools from pressurized hoses and pipes. Connectors are constructed out of Polypropylene.



Fig.4.3 Connectors

Hoses

Compressed air travels through hoses, which are flexible tubes. Aluminum, plastic, rubber, polyvinyl chloride, and other synthetics are all common choices for hose manufacturing. As shown in Fig.4.4



Fig.4.4 Hoses

Air compressor

Pneumatic systems depend on a supply of compressed air, which needs to be made available in enough volume and at a pressure appropriate for the system's capacity. However, it will be important to address the issue of compressed air supply when a pneumatic system is implemented for the first time. Any facility that supplies compressed air must use a reciprocating compressor as a vital component. A compressor is a device that can provide air at high pressure while also ingesting gas at a specific pressure. The actual amount of compressed and delivered air is referred to as compressor capacity, and the volume expressed is the air at intake conditions, namely at atmospheric pressure and normal ambient temperature. One of the elements that affects a compressor's life is how clean the suction air is. Increased condensate precipitation from compressed air will arise from warm, humid

suction air.



Fig.4.5 Air compressor

The sizing of air reservoirs requires taking into account parameters such as system pressure and flow-rate requirements, compressor output capability, and the type of duty of operation. It also serves to pressure pulses either coming from the compressor or the pneumatic system during valve shifting and component operation. The reservoirs are equipped with a safety relief valve in order to prevent the explosion of tank. The equation can be used to determine the proper size of the reservoir as

$$V_r = 14.7(Q_r - Q_c) - P_{min}$$

Where t = time that reservoir can supply required amount of air (min)

Q_r = consumption rate of pneumatic system (SCFM, m³/min)

Q_c = output flow-rate of compressor (SCFM, m³/min)

P_{max} = maximum pressure level in reservoir (psi, kPa)

P_{min} = minimum pressure level in reservoir (psi, kPa)

V_r = reservoir size (ft³, m³) Air capacity rating of compressors Air compressors are generally rated in terms of SCFM of free defined as air at actual atmospheric conditions.

The equation that allows for this calculation is Power required to drive the compressor The following equation can be used to determine the theoretical power required to drive an air compressor.

Theoretical power (in terms of HP) is given by the formula Theoretical power (in terms of kW) is given by the formula

P_{in} = inlet atmospheric pressure (psia, kPa abs)

P_{out} = outlet atmospheric pressure (psia, kPa abs)

Q = flow-rate (standard m³/min)

CHAPTER 5

MANUFACTURING PROCESSES

CHAPTER-5

MANUFACTURING PROCESSES

Manufacturing processes are the steps through which raw materials are transformed into a final product. Manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part. Manufacturing processes can include treating, machining, or reshaping the material. The manufacturing process also includes tests and checks for quality assurance during or after the manufacturing, and planning the production process prior to manufacturing .

Laser beam machining (LBM)

Lasers can be put to many different tasks. For instance, they can be utilized in the cutting of metal plates. When applied to plate materials like mild steel, stainless steel, and aluminium, laser cutting provides pinpoint accuracy, superior cut quality, a narrow kerf width, a restricted heat impact zone, and the ability to carve intricate shapes and microscopic holes.

Most people know that "LASER" refers to Light Amplification by Stimulated Emission of Radiation. The laser beam is a narrow, intense shaft of light with a certain colour and wavelength. In a standard CO₂ laser, this phenomenon happens in the infrared portion of the light spectrum, making it invisible to the naked eye. From the laser resonator, which produces the beam, the beam's diameter is about 3/4 of an inch; this is about the same diameter as the beam as it travels along the machine's beam path. It may first be reflected off of a series of mirrors called "beam benders" before being focused onto the plate. The laser beam is guided through a nozzle's bore before it reaches the plate. Through that nozzle bore is also coming a compressed gas like oxygen or nitrogen.

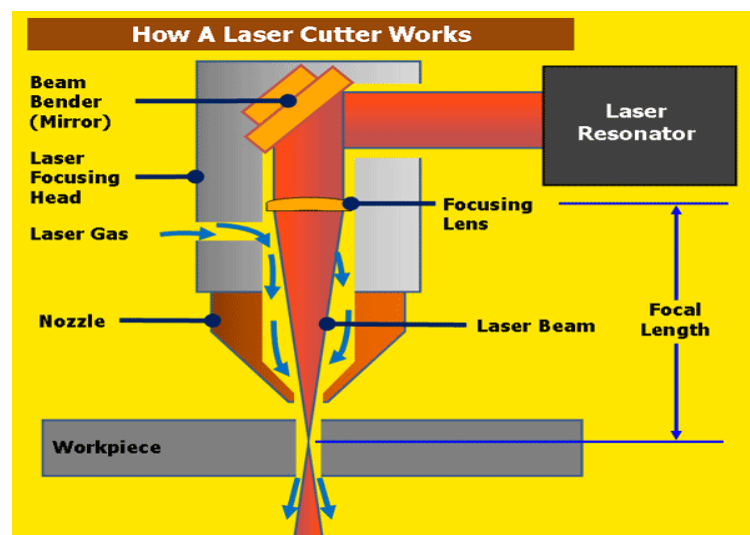


Fig.5.1 Laser beam machining

HAND HACKSAW

A hacksaw has small, sharp teeth and was first and foremost designed for cutting metal. Similar saws, called bow saws, are also used to cut wood. Hacksaws, a type of hand saw, typically have a C-shaped frame that compresses a blade. Hacksaws like these have pins on the handle (often shaped like a pistol grip) that secure a short, disposable blade. The frames may be adjustable so that different sized blades can be used. A screw or other mechanism is used to maintain tension on the thin blade. Like most frame saws, hacksaws include a blade that can be adjusted so that the teeth face either toward or away from the handle, allowing the saw to be used for cutting on either the push or pull stroke. When sawing horizontally downward while holding the work in a bench vice, the hacksaw blade is often placed so that the cutting edge is facing front.



Fig.5.2 Hand hacksaw

DRILLING

Drilling is a form of cutting where a circular hole is bored out of a solid object using a drill bit. Typically, the drill bit is a revolving, multi-pointed cutting tool. The bit is pressed against the work-piece while spinning at speeds of several hundred to several thousand revolutions per minute. This pushes the cutting edge toward the work-piece by removing chips from the hole while it is being drilled.



Fig.5.3 Drilling

When drilling into rock, it is common practise to spin the bit, however this does not necessarily result in a circular cut. A drill bit is often hammered rapidly into the hole several times to form the hole. Top-hammer drills have hammering mechanisms on both the inside and the outside of the bit, allowing for drilling in both directions (down-the-hole drill, DTH). Drifter drills, often known as horizontal drilling rigs, are specialized tools used to bore horizontal holes.

LATHE TURNING

Turning is a type of machining in which a cutting tool (usually a non-rotary tool bit) moves along a helical toolpath as the workpiece rotates. Tools' axes of motion are essentially linear, even if they may be along a straight line, a sequence of curves, or an angle (in the non-mathematical sense). Conventionally, the term "turning" is used to refer to the process of creating external surfaces via this cutting action, while

the term "boring" is used to refer to the process of creating internal surfaces via this same fundamental cutting action (that is, holes of various types). As a result, the term "turning and boring" is used to describe a broader group of (roughly analogous) lathing operations.



Fig 5.4 Lathe turning

ARC WELDING

Arc welding is a method of combining metals in which electricity is used to provide enough heat to melt the metal, which is then allowed to cool and congeal as a joint. By striking an electric arc between an electrode and the base material, a welding power supply liquefies the metals at the welding spot. Direct current (DC) or alternating current (AC) can be used, and either disposable or permanent electrodes can be used. Welding areas are typically shielded using gas, mist, or slag. Arc welding procedures can be fully automated, semi-automated, or performed by hand. Although technique wasn't widely adopted until after World War II, arc welding's origins may be traced back to the second half of the 19th century. It is still an essential process in the making of steel structures and vehicles.



Fig.5.5

WORKING PRINCIPLE

CHAPTER-6

WORKING PRINCIPLE

Lifting air pressure from low to high is the main goal of a pneumatic power steering system. This can be done by reducing the airflow. Pushing the solenoid valve's lever to its left side allows air to flow through a pneumatic cylinder, as air compressors are typically positive displacement devices. There are five openings and three positions on this solenoid valve. There is one intake port, two discharge ports, and two venting apertures. In the two extreme positions, you can only modify the orientation, but in the middle, nothing changes in terms of its actual form. There are two wires that connect the actuator to the inlet and outlet ports (Cylinder). Through the actuator valve, pressurized air can enter the cylinder block's front end. The air pressure is used to drive the piston backwards during the recovery stroke. At the conclusion of the cutting stroke, air from the solenoid valve enters the cylinder block from behind.

The control valve keeps the pressure steady while decreasing the available surface area. Consequently, the piston is subjected to a greater amount of pressure and is able to travel at a faster rate, resulting in a shorter return stroke. Two different types of compressors are used, one of which is a tiny air compressor and the other a larger, two-stage compressor unit. Compressed air is fed into the solenoid valve from the compressor. Solenoid valves are used to control flow in response to signals from a timing device. It is equipped with a motor, a pulley drive, a pressure regulator, and pressurized air tanks that can be used in a hurry. When the predetermined pressure is surpassed, the excess air is let out through a release valve. The compressor has a 10 HP engine and is designed to work at pressures of 145-175 PSI. When air enters the air fitter from the compressor, it is compressed. It's filtered out all the microscopic dust particles. Therefore, pneumatic systems are used to regulate the power steering.

3-D DESIGN OF PNEUMATIC POWER STEERING SYSTEM

CHAPTER-7

3-D DESIGN OF PNEUMATIC STEERING SYSTEM

FRONT VIEW OF PNEUMATIC STEERING SYSTEM

The wheels, pneumatic actuator, and frame, among other components, may be seen in the front view of the pneumatic power steering system. As shown in the figure.7.1

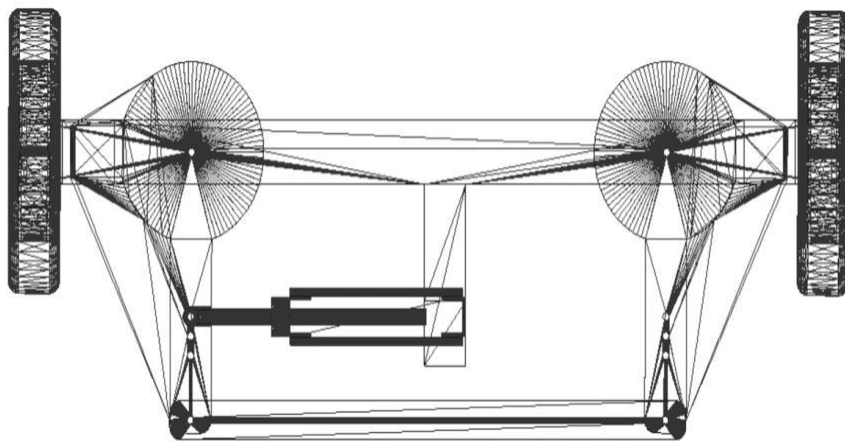


Fig.7.1 Front view of Pneumatic Steering system

REAR VIEW OF PNEUMATIC STEERING SYSTEM

Wheels, a pneumatic actuator, a frame, and other components can be seen when

looking at the rear of the pneumatic power steering system. As shown in fig.7.2

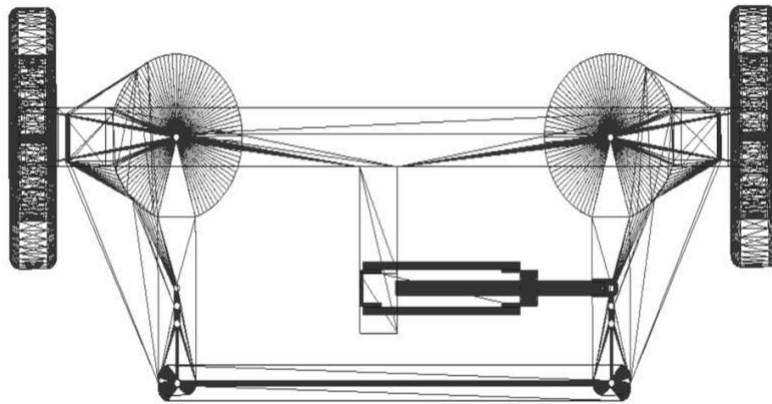


Fig.7.2 Rear view of Pneumatic steering system

LEFT VIEW OF PNEUMATIC STEERING SYSTEM

The pneumatic power steering system is depicted on the left as wheels, pneumatic actuators, and frames. As shown in fig.7.3

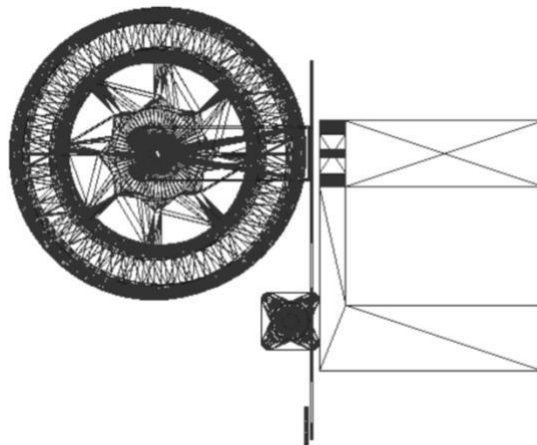


Fig.7.3 Left view of Pneumatic steering system

RIGHT VIEW OF PNEUMATIC STEERING SYSTEM

Wheels, a pneumatic actuator, a frame, and other components make up the

pneumatic power steering system's right view. according to the figure.7.4

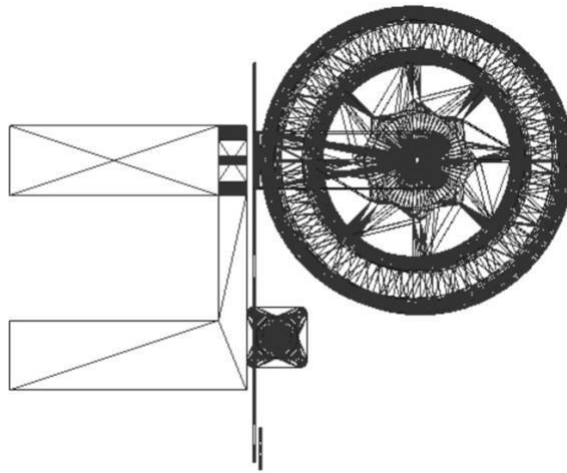


Fig7.4 Right view of pneumatic steering system

ADVANTAGES AND DISADVANTAGES

CHAPTER-8
ADVANTAGES AND DISADVANTAGES

ADVANTAGES

- Manageable in size
- Easy to Operate
- Simple in construction
- Maintenance cost low and easy
- During operations, less time is needed
- Less effort required

DISADVANTAGES

- Loud and noisy
- Sensitive to vibrations

APPLICATIONS

CHAPTER-9 APPLICATIONS

These types of braking system using wide range of applications in the fields like,

- Mechanical engineering.
- Military and defence.
- Automotive.
- Industries.

LIST OF MATERIALS

CHAPTER-10
LIST OF MATERIALS

SL. NO.	NAME OF THE PARTS	MATERIAL	QUANTITY
1	Pneumatic actuator	Copper	1
2	Disc	MS	2
3	5/3 Double acting solenoid valve	Nickel plated brass, PVC,Nylon etc..	1
4	Connectors	Polypropylene	4
5	Hoses	Aluminium, Plastic, Rubber	2
6	Air compressor	Cast iron or Aluminium	1
8	Wheels	PVC, Rubber etc..	2

Table-10.1

COST ESTIMATION

CHAPTER-11

COST ESTIMATION

S.No	Material	Specifications	No of items	Cost per item	Total cost of material
1	Pneumatic actuator	0.5-1.0 Mpa	1	2892 (inc taxes)	2892
2	Ms Disc	Circular disc	2	200	400
3	5/3 Double acting solenoid valve	Double acting directional valve	1	1200	1200
4	Connectors	Air connectors	8	90	720
5	Hoses	Blue pipes	2	220	440
6	Wheels	Plastic or Rubber tires	2	250	500
7	Labour cost	Cutting,welding and assembly	1 person	2000	2000
					8152

Table 11.1 Cost estimation

BUDGET FOR DESIGN AND DEVELOPMENT OF PNEUMATIC STEERING SYSTEM

LABOUR COST

Labour cost includes the following: LATHE, DRILLING, WELDING, GRINDING, POWER HACKSAW, GAS CUTTING.

Cost = 2000

11.3 TOTAL COST

Total cost = Material Cost + Labour cost

= 6152 + 2000

= 8152

Total cost for this project = 8152

CHAPTER-12

CONCLUSION

CHAPTER-12

CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institution and the industries.

We are proud that we have completed the work with the limited time successfully. The **DESIGN AND DEVELOPMENT OF PNEUMATIC STEERING SYSTEM** is working with satisfactory conditions. We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities.

Thus, we have developed a **“PNEUMATIC STEERING SYSTEM”** which is easy to operate in both small and large trucks. This is a form of protection for both the present and the future. This pneumatic steering system

frees up more space for the air bag to perform its function. By using more techniques, they can be modified and developed according to the applications. This is just a prototype of our project which can be tested for real life vehicles and can be readily implemented in automobiles and other applications.

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